

Zen and the art of science communication at National Parks

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Austin, Texas
Annual Inventory & Monitoring Meeting
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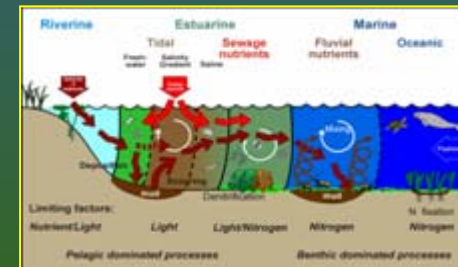
integration

application

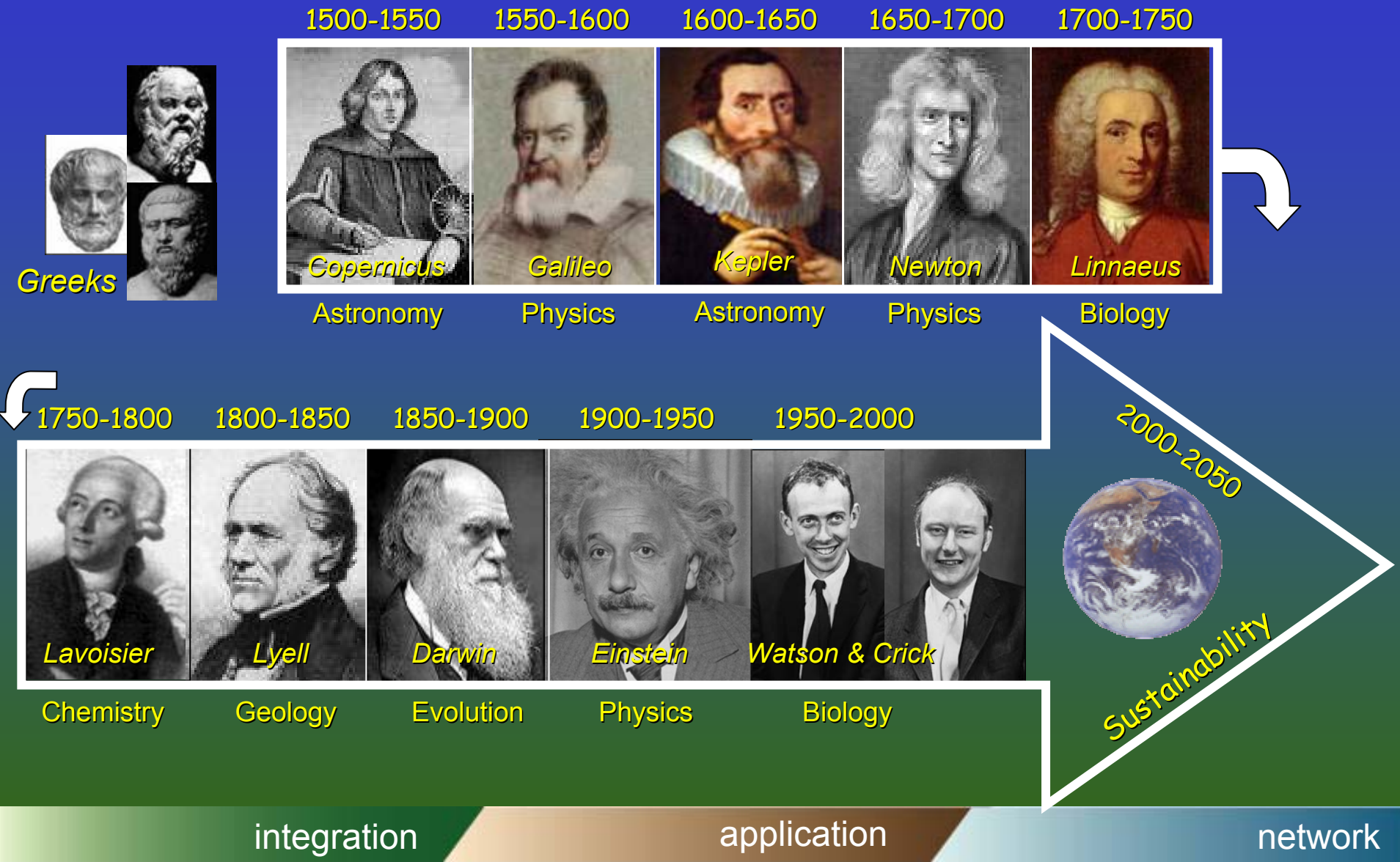
network

Objectives

- *Inspire* you to develop/enhance your science communication skills
- *Provide* some overarching science communication principles
- *Illustrate* an effective science communication program with an environmental assessment case study
- *Introduce* you to conceptual diagram resources



Paradigm shifts occur when scientific discovery is effectively communicated to society





National Park Service has a unique teaching opportunity

- Receptive audience (pre-selected)
- Superb natural setting (illustrate key messages)
- Motivational experiences possible (transform uninterested to interested to informed to empowered)
- Credibility (National Park Service is NOT an NGO chasing \$, NOT an agency with regulatory or development mandates, NOT corporation chasing 'green' credit)



Good science communication can make you a better scientist

Completeness

Envisioning the 'story' can lead to comprehensive research program

Context

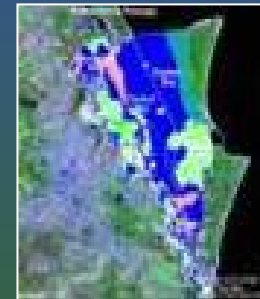
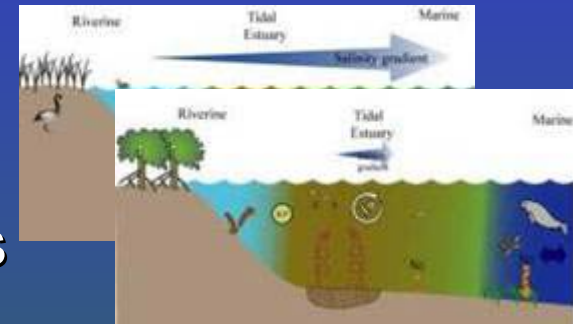
Identifying the linkages and developing comparisons can provide important insights

Visualizations

Combining visual elements can lead to new insights

Synthesis

Combining and comparing different data sets or approaches can lead to insights





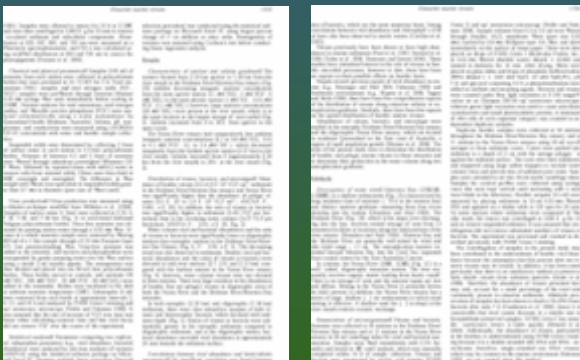
National Park Service has a need for effective science communication

- Public/environment interface (broad audience)
- Diverse parks with diverse issues
- Public expectations of information & 'entertainment'
- Iconic and unusual natural features that require explanation



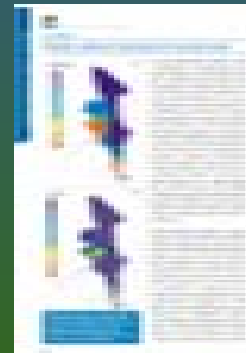
There are differences between science writing & science communication

- Getting it right
- Providing scientific context (references)
- Text > graphics
- Peer audience
- Mostly black and white
- Authorship exclusive
- Focus on results and interpretation



integration

- Getting it done
- Providing societal context (examples)
- Text \approx graphics
- Broader audience
- Full color
- Authorship inclusive
- Focus on conclusions and recommendations



application



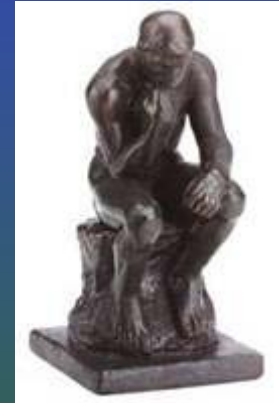
network

The 'zen' of science communication

- *Enthusiasm* counts: get excited



- Give yourself adequate *quality time*



- *Feedback & revision* essential: seek it out



The art of science communication

- **Conceptual diagrams:** context and synthesis
- **Maps:** geographic context and information-rich
- **Photos:** describe methods, study site description, processes and relevance
- **Video clips:** capture system dynamics
- **Tables and figures:** scientific data





National Park Service can access abundant visual elements

- High quality photos
- Maps & various GIS products available
- Text can be augmented with quotes (historical, poetic, etc.)
- Data generally available
- Conceptual diagrams have been initiated for National Capital Region Parks





National Park Service - consider creating/enhancing digital libraries

- Image library
- Map library
- Quote library
- Symbol library
- Libraries could be on a distributed network with web access; searchable data base

Principles of science communication

1. Provide synthesis, visualization & context
2. Relate to audience – big picture to local relevance
3. Simplify terms but not content
(don't *dumb it down*, do *raise the bar*)
4. Assemble self-contained visual elements
5. Consistent *style* **and** *format*
6. Lose the jargon, dude
7. Define all terms, e.g. SE = Standard Error
8. Minimize AU (Acronym Use)
9. Engage audience: prepare for and invite questions
10. Use **color**, **but** use it judiciously

Synthesis, visualization & context are key elements of science communication

Synthesis



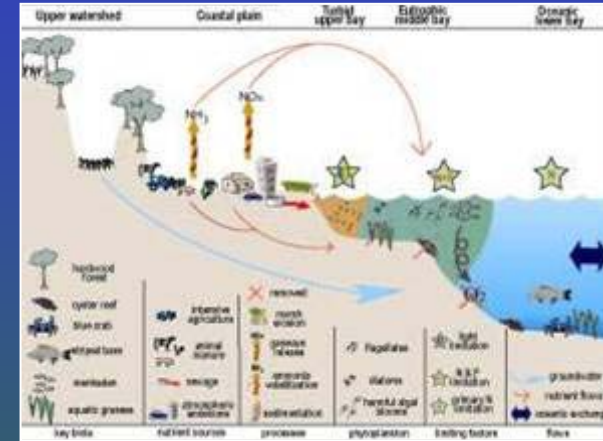
Provide analyzed, interpreted & synthesized data

Visualization



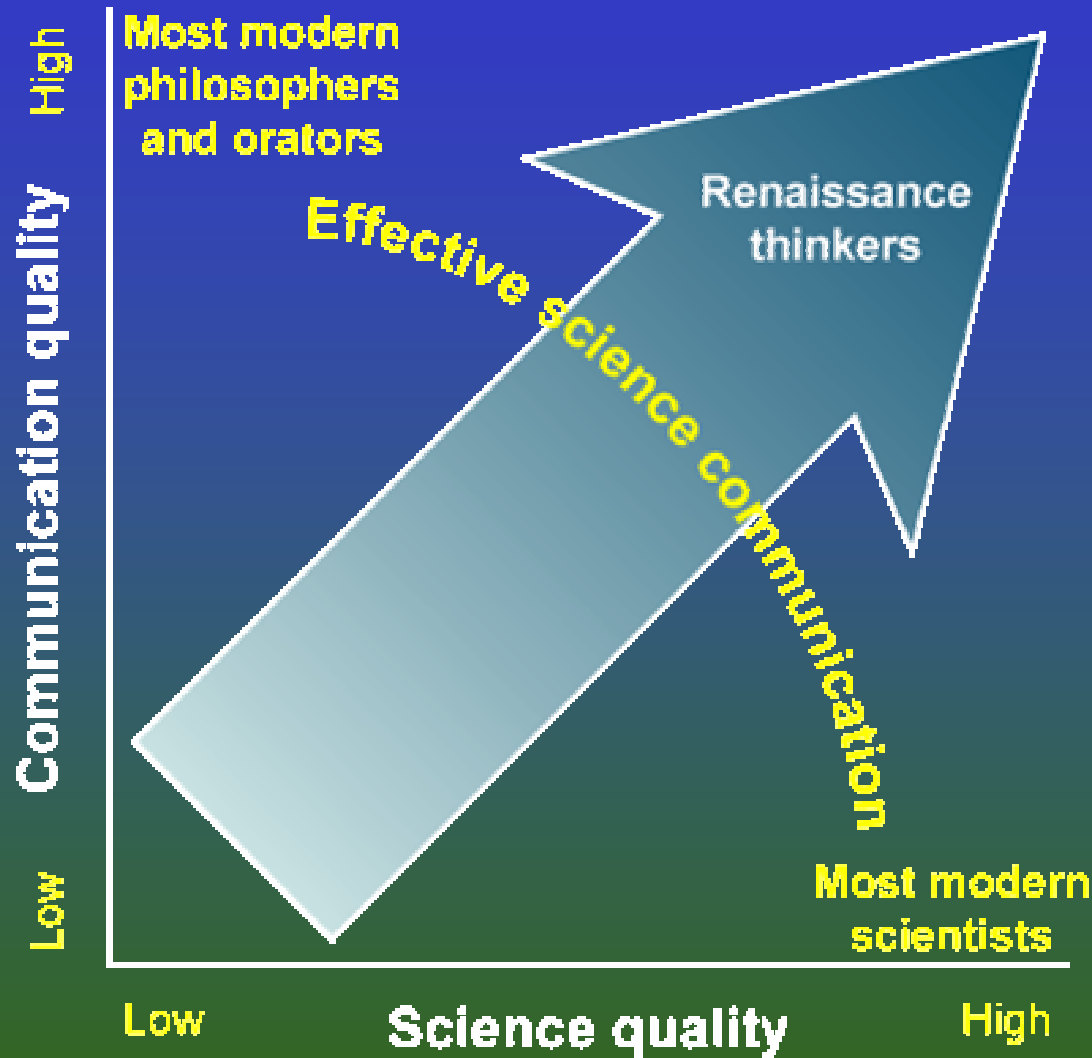
Show them: who, what, where, when, how & so that you can tell them why

Context



Provide answers for: “Why should I care?” & “So what?”

Good science communication requires attention to both the science and the presentation



“What you've got here, really, are two realities, one of immediate artistic appearance and one of underlying scientific explanation, and they don't match and they don't fit and they don't really have much of anything to do with one another. That's quite a situation. You might say there's a little problem here.”

Robert Pirsig, 1974



Principles of Analytical Design; E. Tufte



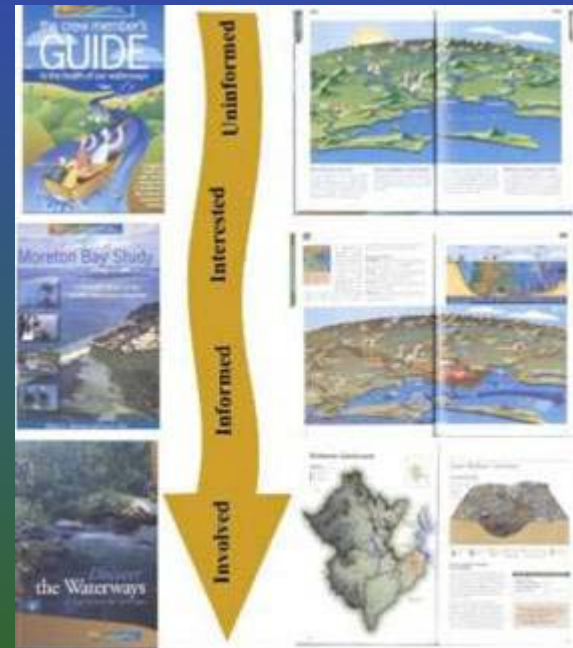
- “Don’t get it original, get it right”
- Integrate word, image, numbers
- Include documentation (data sources)
- Content-driven; presentation enables thinking
- Put important comparisons adjacent in space
- Use small multiples (maximize content variation; minimize style variation)
- Audiences are precious (know your content; respect your audience)
- Use humor, memorable hyperbole
- **Preparation:** Practice, practice, practice; develop better content



Good science communication is no JOKE

JOKE = Jargon-filled, Obtuse language that Keeps audience Entirely ignorant

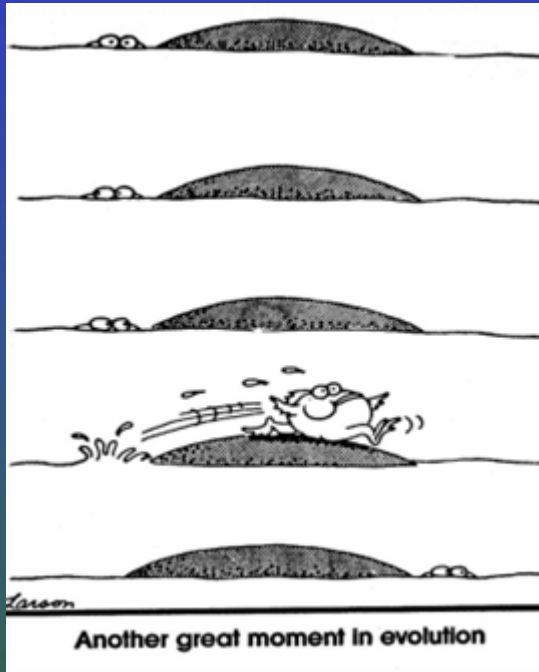
Science communication that relies extensively on JOKEs is a self-indulgent representation of simple ideas, obfuscated with technospeak to make the scientist appear astute, yet serves to be obtuse and belittles the audience.



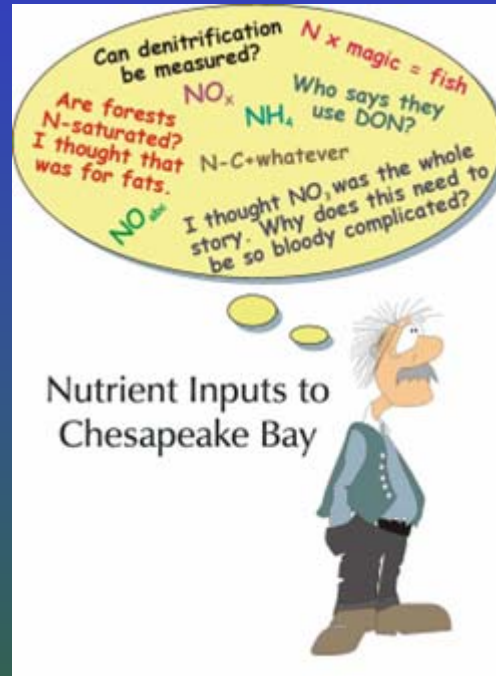
Design layout approach; content-rich, communication-based

Topical humor can be effective

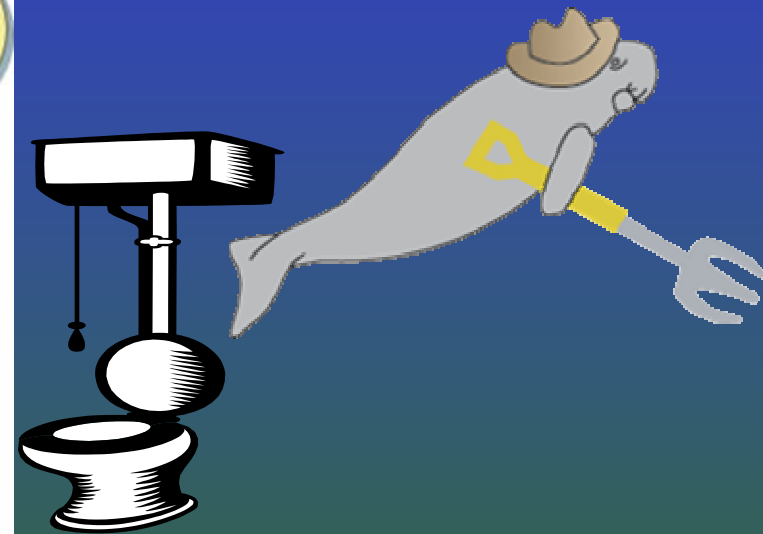
Seagrasses 'reinvaded' the sea from terrestrial ancestors



Walt Boynton's caricature



"Cultivation grazing" by dugongs structures seagrass communities



Acknowledgements

Thanks to all the people in the Chesapeake Bay watershed who contributed their nutrients to this study.

Effective communication is two-way

How do you elicit two-way communication?

- **Provide feedback opportunities:** complete the presentation within allotted time (or even shorter); have evaluation sections on science communication products
- **Solicit:** At the end of your talk offer to answer questions; ask for evaluation of science communication products

How do you prepare for questions?

- **Anticipate:** think about what questions you would ask; use practice sessions to solicit and answer questions; develop FAQ (Frequently Asked Questions) section
- **Prepare:** have extra material which can be used in the event of questions
- **Don't be afraid:** it is legitimate to say a) “I don't know”; b) what you do know that is relevant to the question

Monitoring program case study: Moreton Bay, East coast Australia



27°S



integration

application

network

What is "ecosystem health"?

- Key processes operate to maintain stable & sustainable ecosystems
- Zones of human impacts do not expand
- Critical habitats remain intact

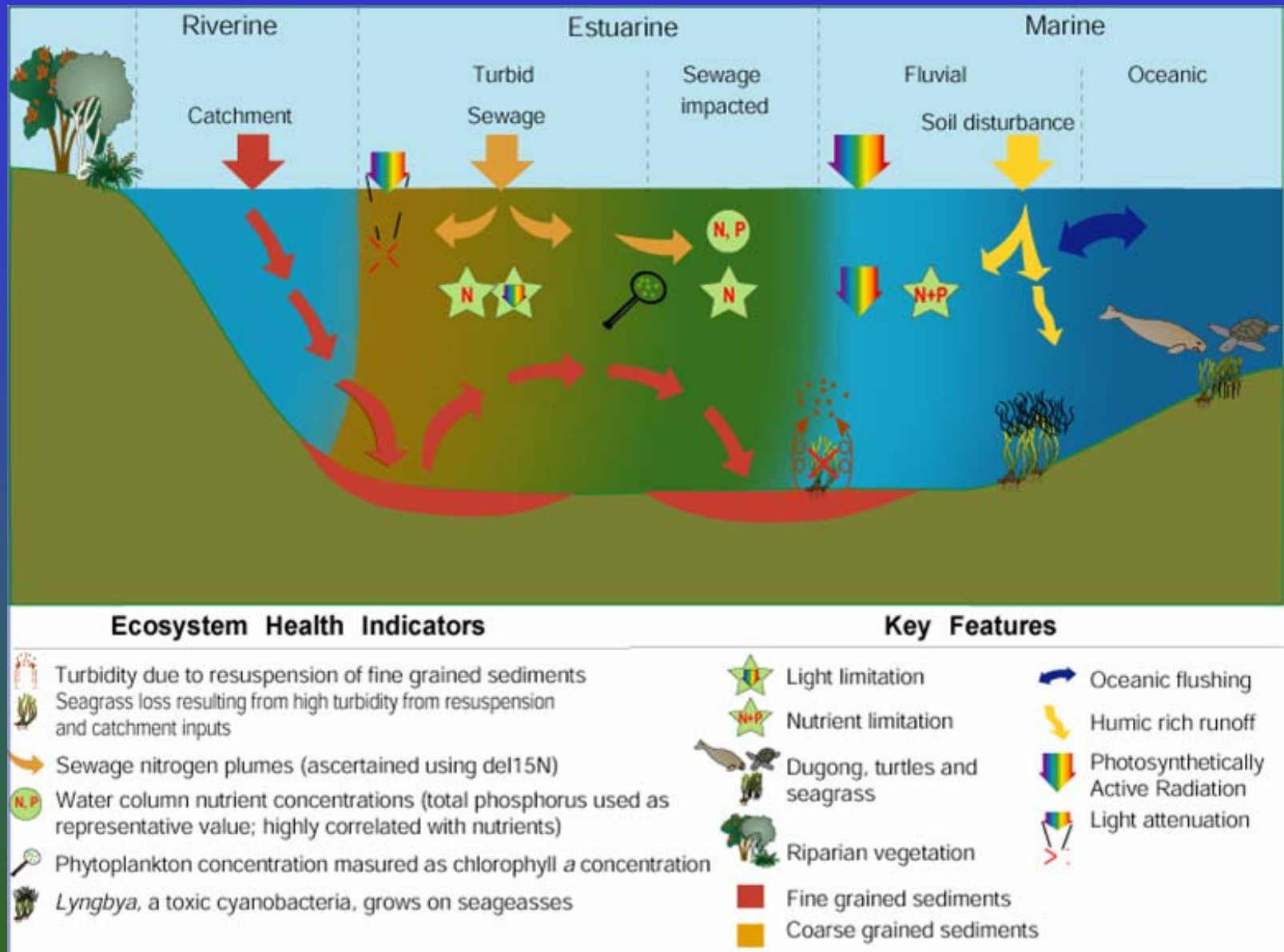
Healthy ecosystem



Unhealthy ecosystem



Ecosystem health indicators: Moreton Bay



Management objective → Ecosystem health indicator → Reference value

- Clear water



Turbidity



Secchi < 1.7 m

- Maintain seagrass habitat



Seagrass area



Historical distribution

- Reduce sewage inputs



Sewage plume mapping



$\delta^{15}\text{N}$ < 4 ppt.

- Reduce nutrients



Total phosphorus



<1.6 μM

- Reduce phytoplankton

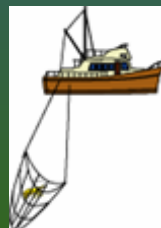


Chlorophyll a



<1.0 $\mu\text{g/L}$

- Reduce harmful algal bloom



Extent of *Lyngbya* bloom



Historical distribution

integration

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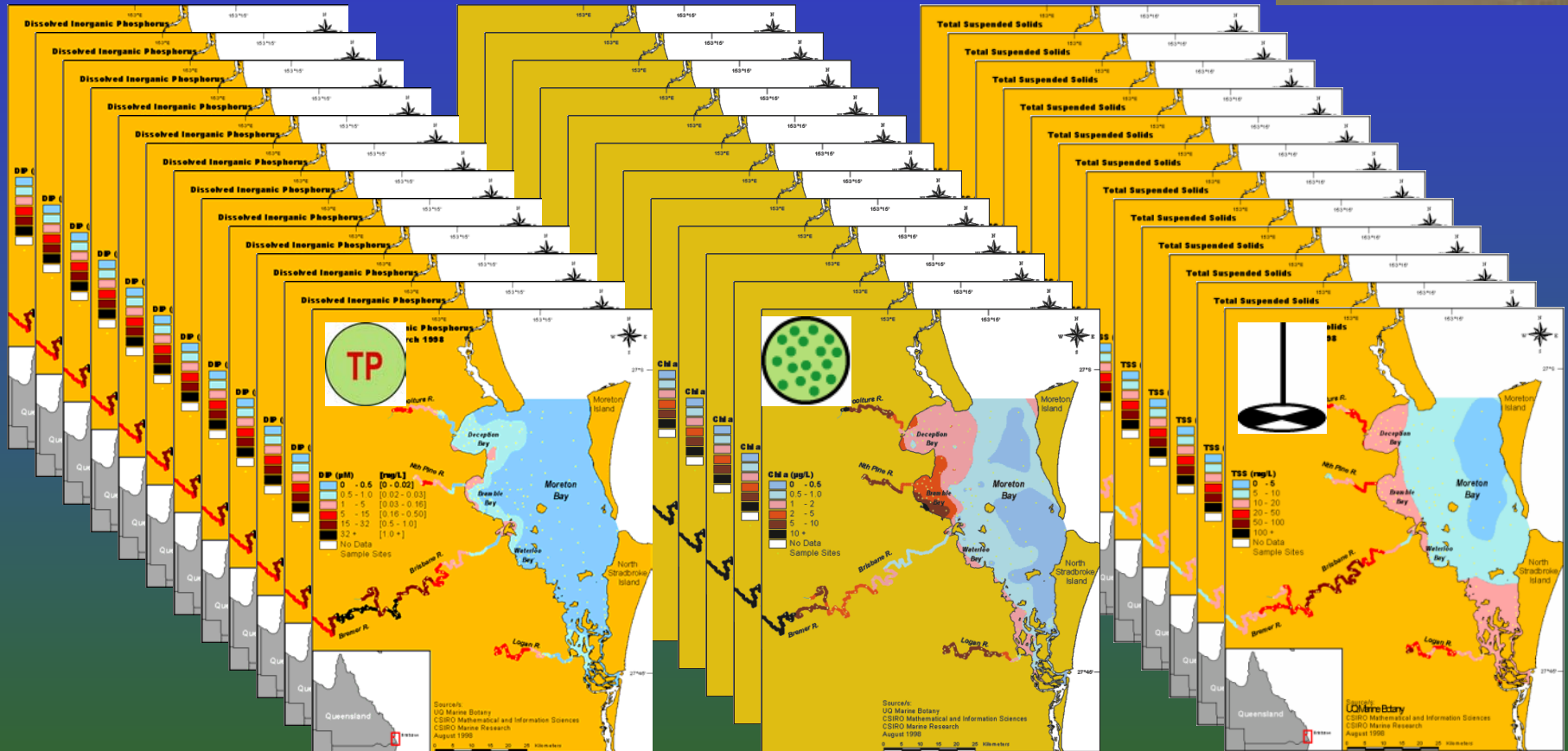
Some ecosystem health indicators monitored monthly



Total phosphorus

Chlorophyll a

Secchi depth

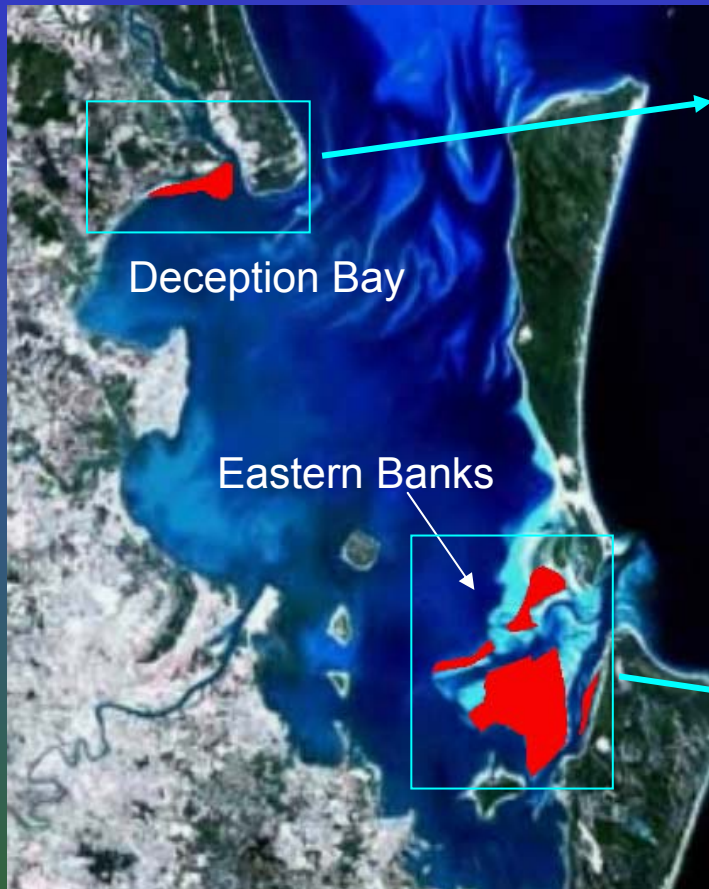


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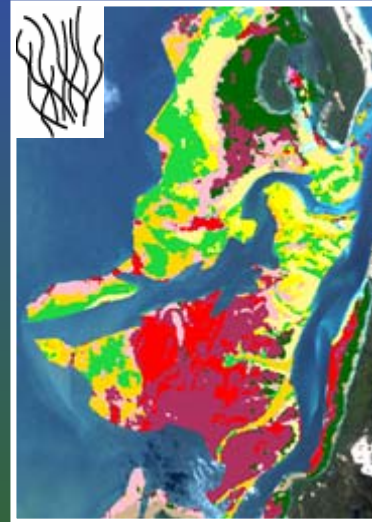
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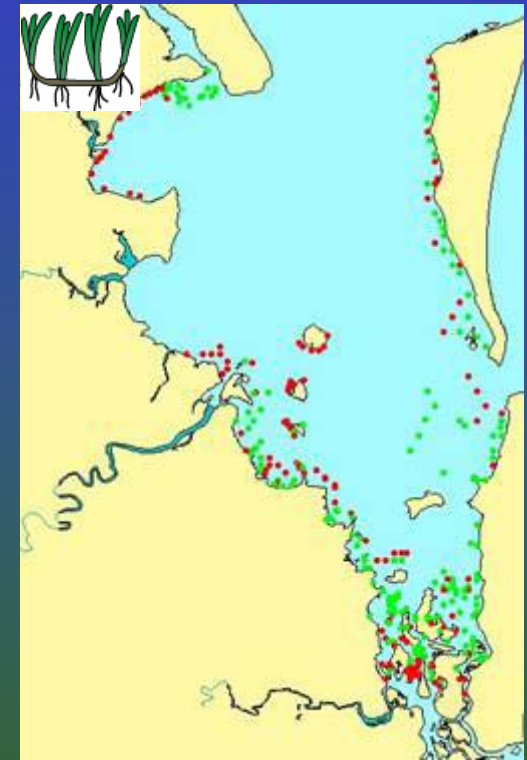
Seagrass and *Lyngbya* blooms mapped using remote sensing and field observations



Extent of *Lyngbya* bloom



Landsat TM

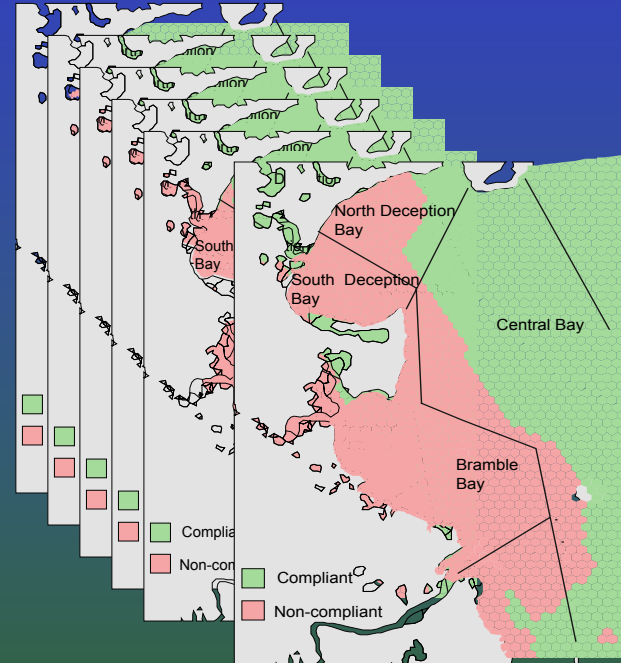
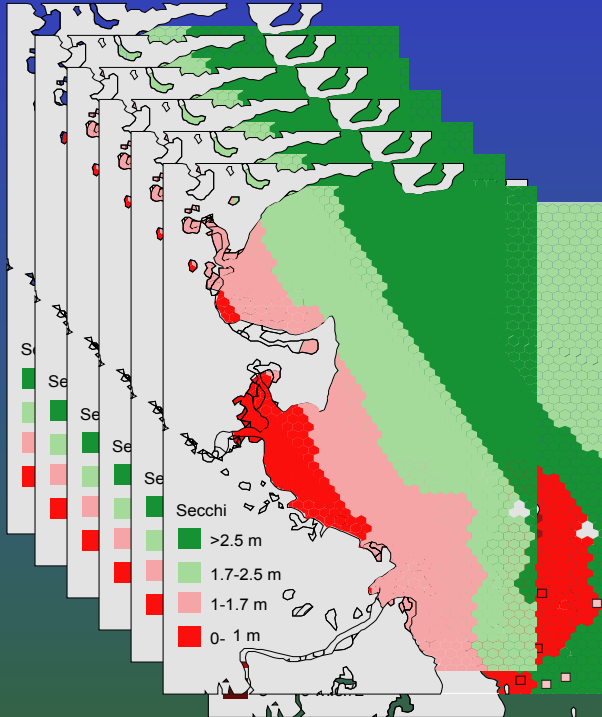


Seagrass distribution

Maps of ecosystem health indicators

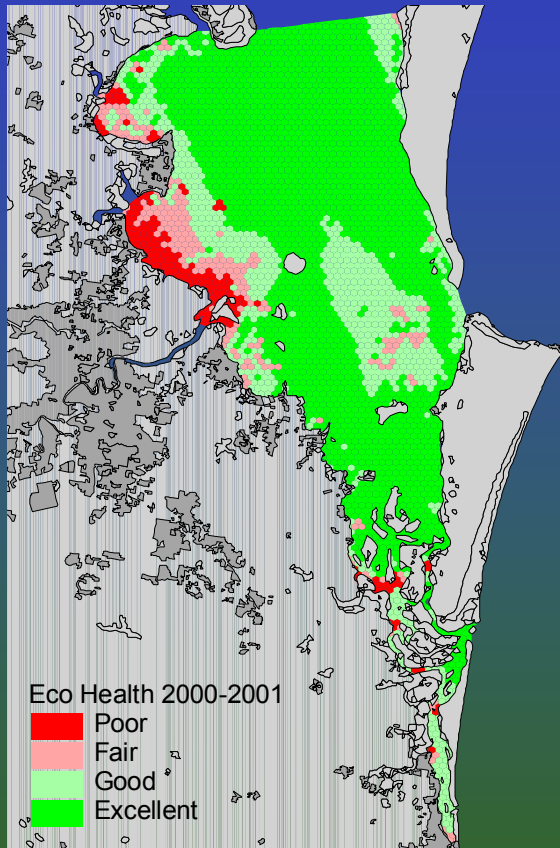


Maps of reference values

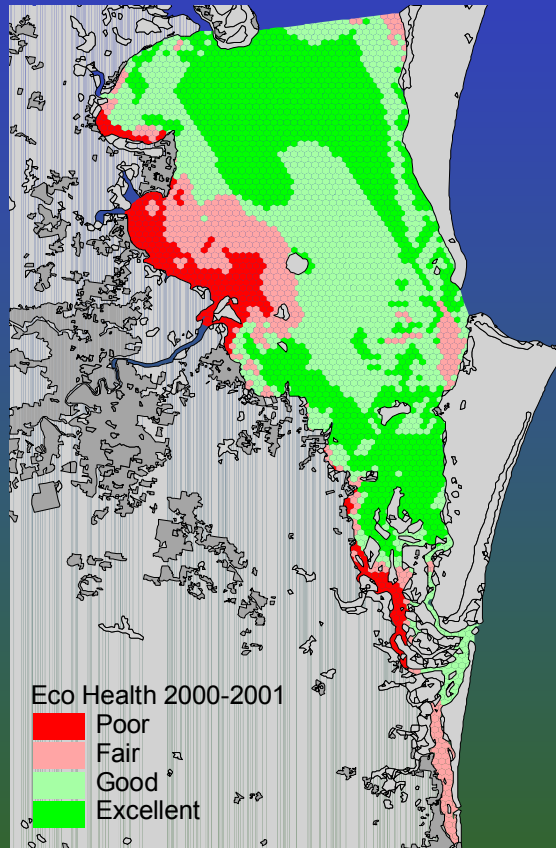


Area-weighted averaging generates maps of ecosystem health index

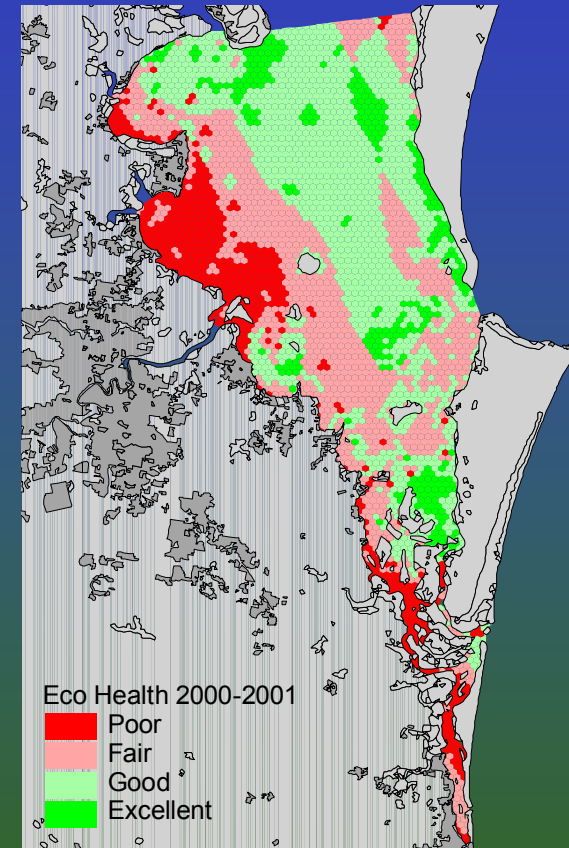
-2 Standard
Deviations



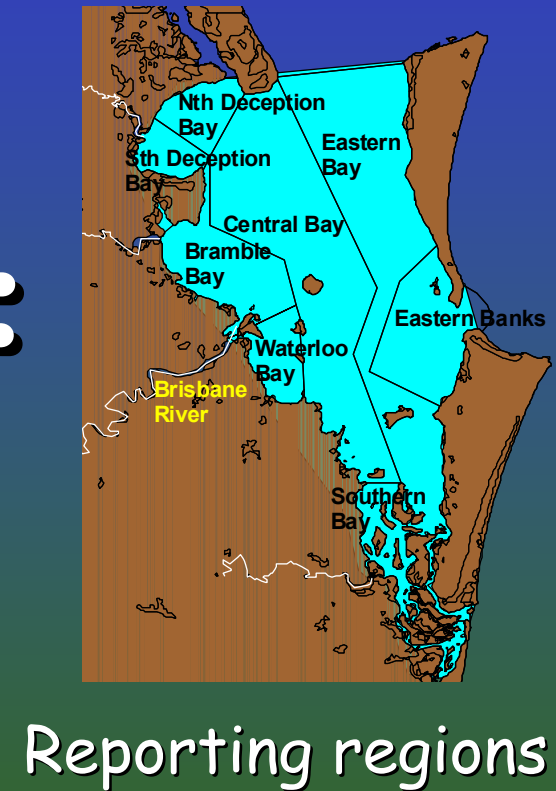
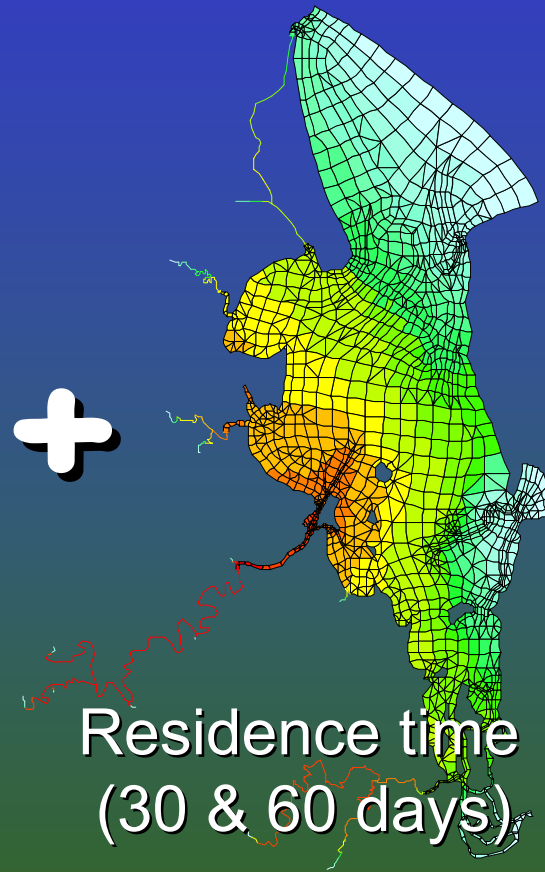
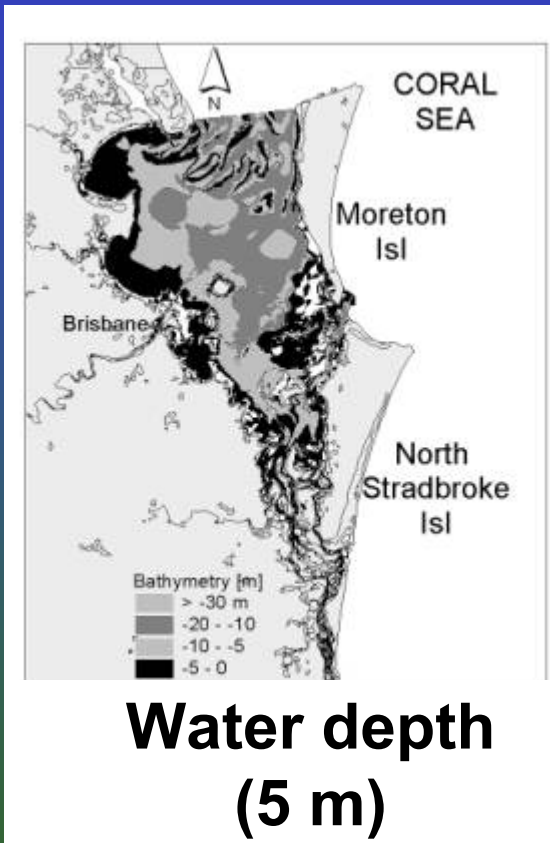
Mean



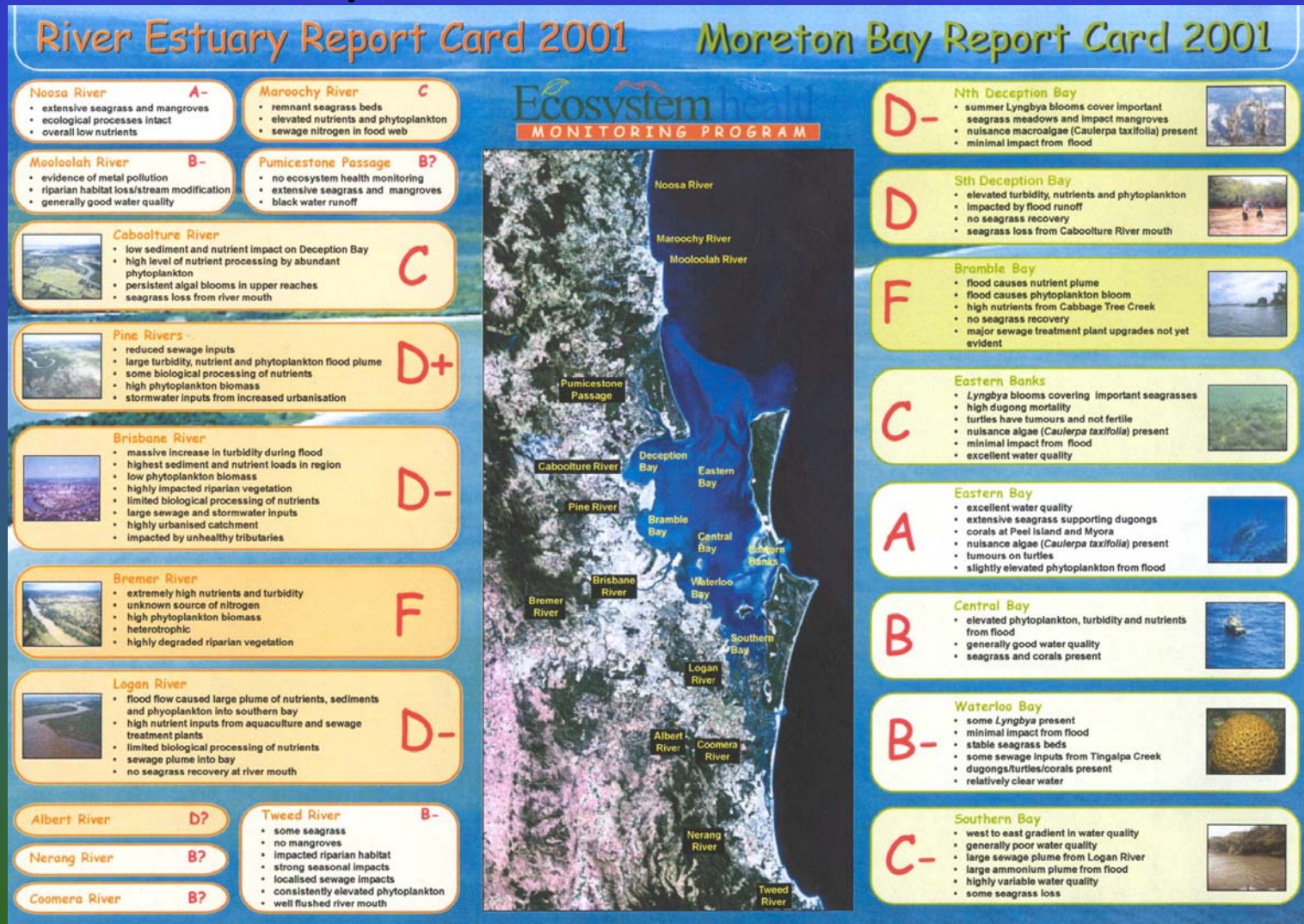
+2 Standard
Deviations



Reporting regions based on water depth and residence time



Ecosystem health values converted into report card values (A - F)



Well informed community taking appropriate measures

Redcliffe gives Moreton Bay \$16 million health boost



Water Treatment Plant Leads Australia with New Technology.

A new water treatment plan at Caboolture is leading Australia with



Big steps towards a healthier Bay

The Brendale Wastewater Treatment Plant has undergone a \$7 million upgrade. Pine Rivers Shire Council funded the upgrade with the help of a 40 percent subsidy from the

\$2b plan to save Brisbane River, bay

By ELLA RIGGERT
City Hall reporter

A \$2 BILLION rescue plan to save the Brisbane River and

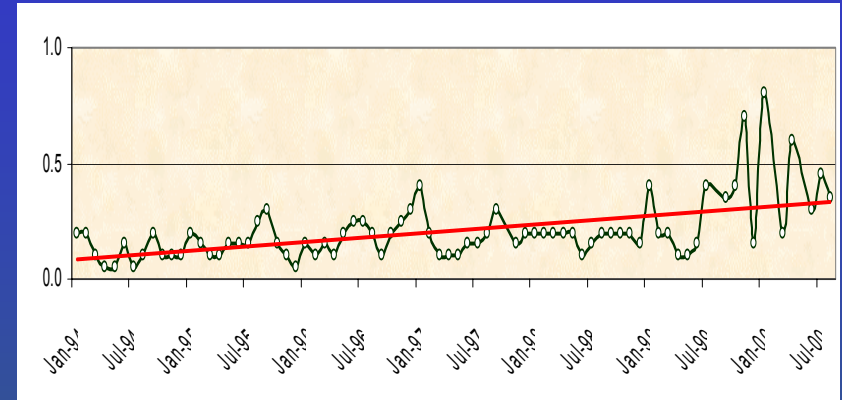
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Ecosystem health improvements evident

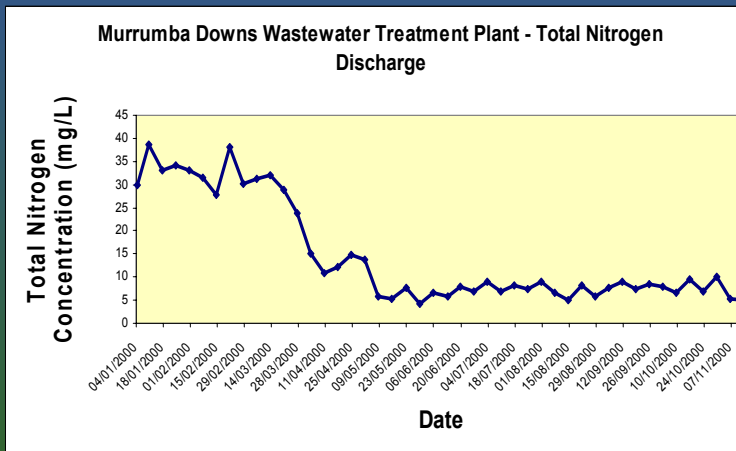
River turbidity decreased



Reduced sewage plumes



1998



Reduced sewage nutrients



2001

integration

application

network

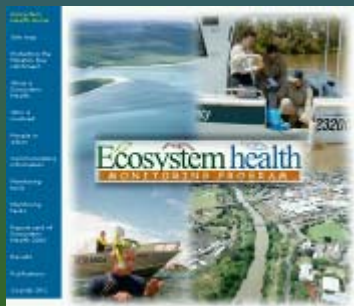
Effective communication central to success

Continual release of communication products

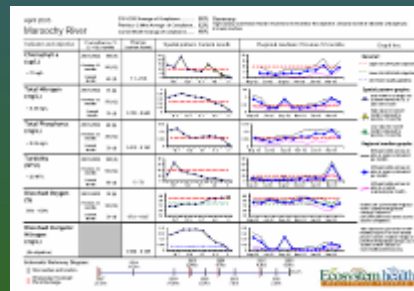
- Keeps stakeholders and community aware of developments
- Increases knowledge of community & stakeholders
- Keep profile of program raised
- Instigates action (report card)



Reports



Website
integration



Monthly data report



Newsletters



Report Card

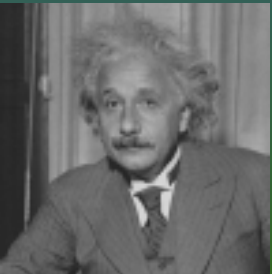
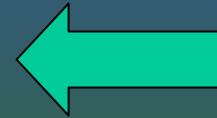
network

Conceptual diagrams

Goal: Scientists able to create and edit conceptual diagrams, improving their science communication skills

Rationale:

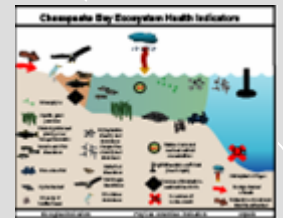
- Conceptual diagrams have proven useful for science integration and application
- Technological advances have made it possible to 'click & drag' using symbol libraries (you don't need to be an artist)



"Make everything as simple as possible, but not simpler." A. Einstein

What is a conceptual diagram?

- “Concept” from Latin *conceptus* (meaning thought); something conceived in the mind (Webster’s 3rd Dictionary, 1986)
- “Diagram” from Greek *diagramma* (meaning to mark out by lines); a graphic design that explains rather than represents, a drawing that shows arrangement and relations (Webster’s 3rd Dictionary, 1986)
- “Model” from Latin *modulus* (meaning small measure); an abstract representation of a system or process (Turner, Gardner & O’Neill, 2001)
- **Conceptual diagram** = A diagram using symbols that depicts the essential attributes of a system



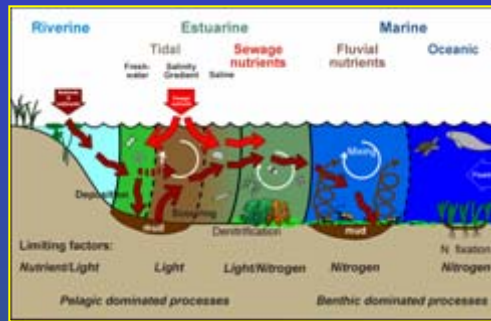
Conceptual diagrams provide an interface

Science

Conceptual
Diagram

Community

Current
understanding

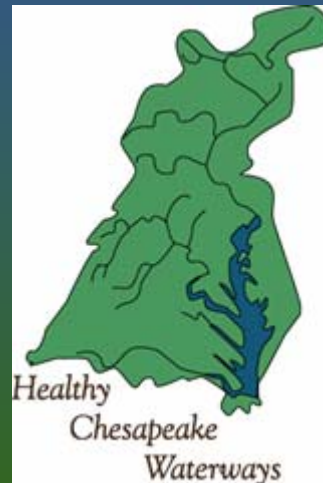


Priorities &
environmental
values

Credibility &
support

Shared vision

Commitment &
resources



integration

application

network

Good conceptual diagrams are used extensively

Z scheme of photosynthesis

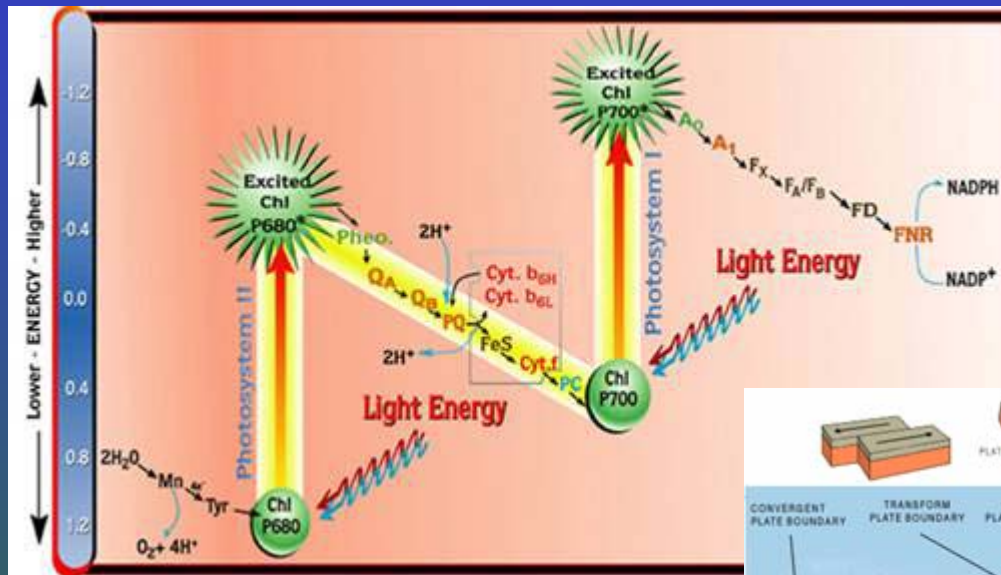
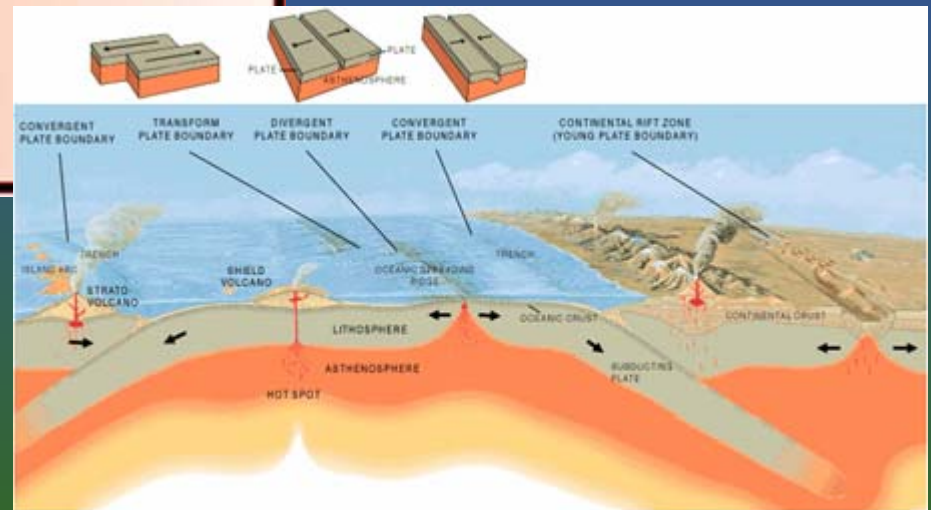
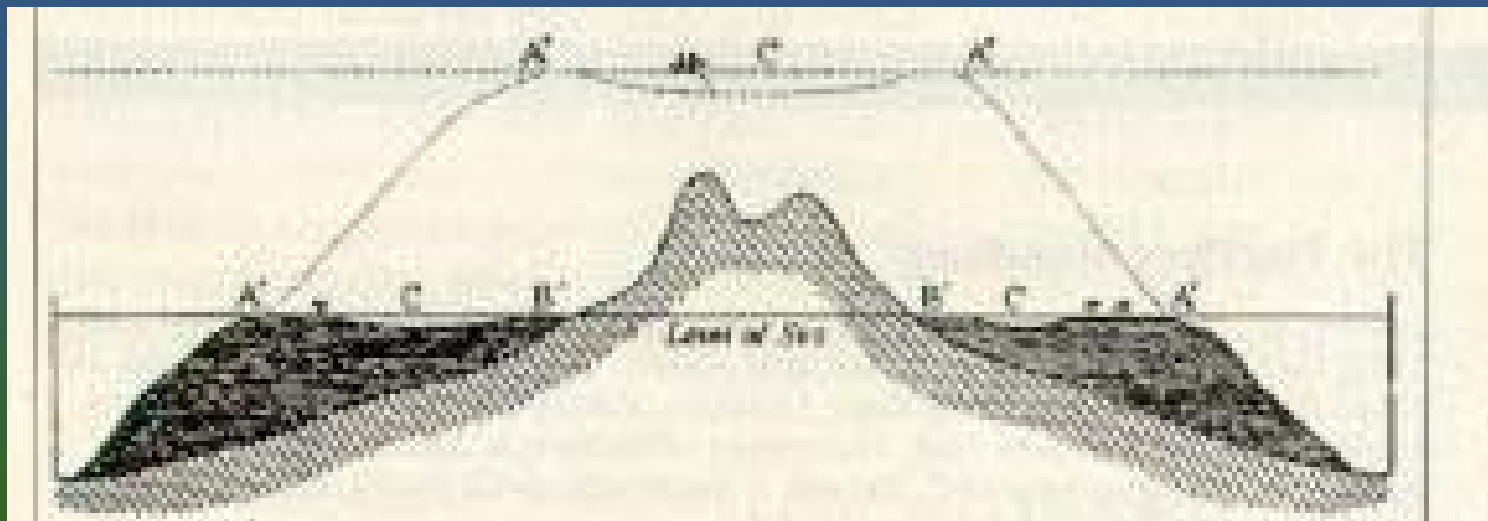
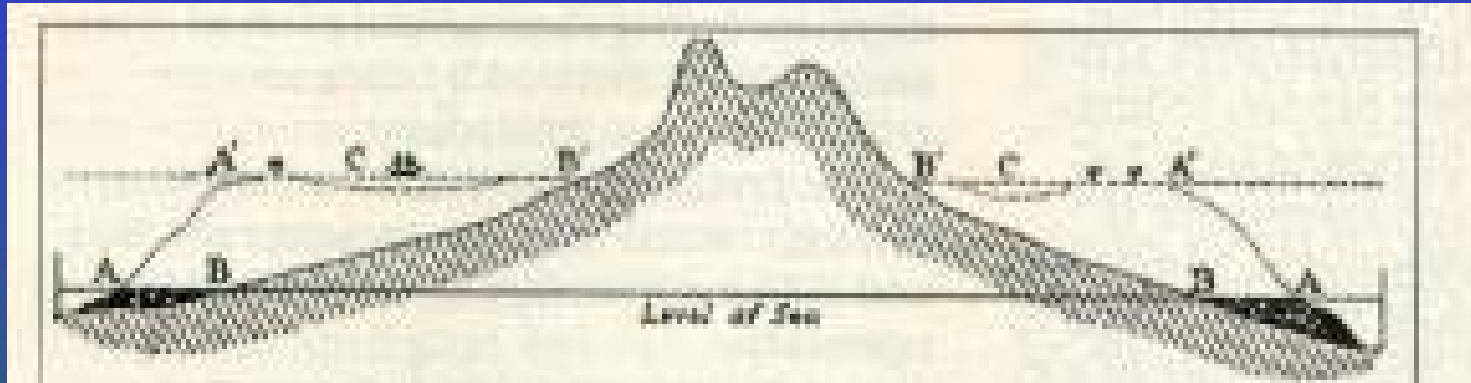


Plate tectonics



Darwin used conceptual diagrams to explain his theory of coral reef formation



integration

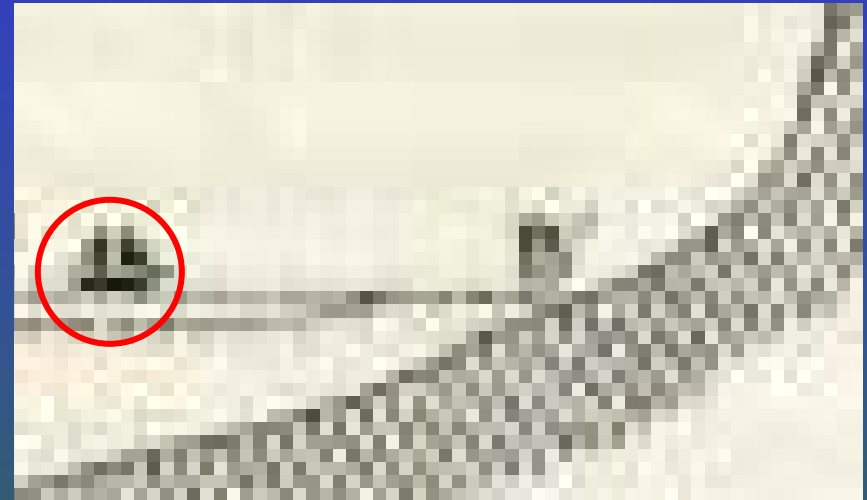
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Conceptual diagrams use symbols: an ancient technique to depict unequivocal messages













Cave drawing (Australian
aborigines)

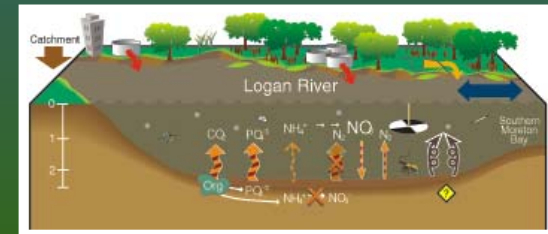


Darwin's conceptual diagram



Symbols (icons) are a key element of conceptual diagrams

- Symbol: from Greek *symbolon* (token of identity) and Latin *symbolum* (token, sign)
- Icon: from Greek *eikon* (to resemble) = pictorial representation
- Symbol: A sign that signifies by virtue of sharing a property with what it represents
 - a. something that stands for or suggests something else 
 - b. a visible thing that stands for something invisible or intangible 
- Symbols used in mathematics (e.g., π), chemistry (e.g., ^{210}Pb), music (e.g., ) weather (e.g., ) religion (e.g., ) corporations (e.g., ) and organizations (e.g., )
- Symbols can be universal; language independent 
- Symbols are scalable; size of symbol can represent relative importance--
 vs. 
- Symbols can be information-rich; size, shape, color and position of symbols can convey information






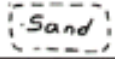






Symbols are an important feature of everyday life



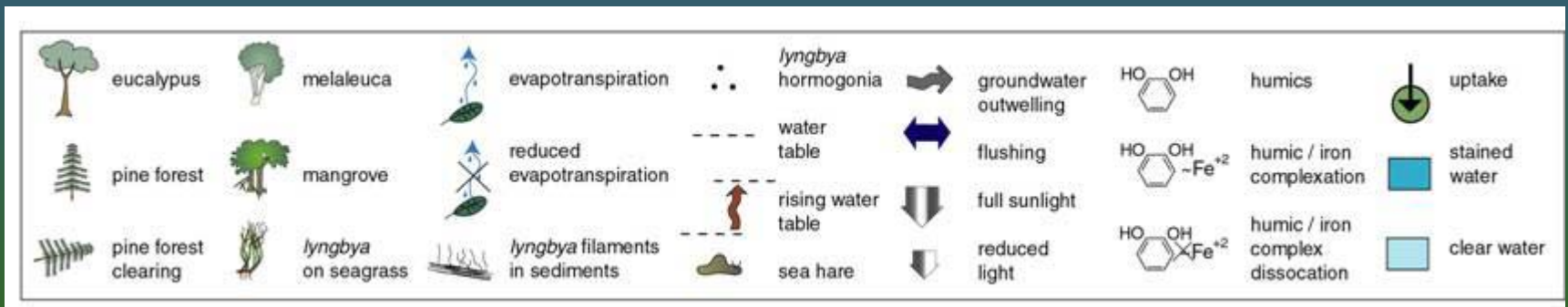
Shape, color and images used for traffic signs

In conceptual diagrams, as in maps, symbols need to be explained in a legend

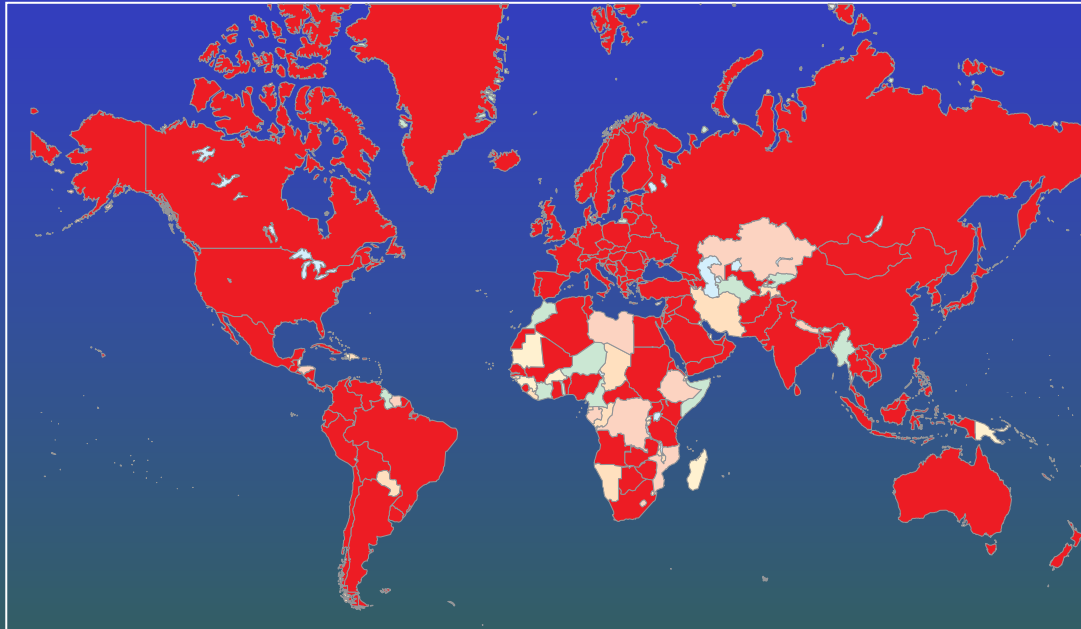
Map legend:

SURFACE FEATURES		
Levee		
Sand or mud area, dunes, or shifting sand		
Intricate surface area		
Gravel beach or glacial moraine		
Tailings pond		

Conceptual diagram legend:



Developing a global symbol language



~6000 people from 149
countries (■) registered

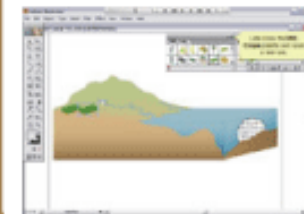


1000+ symbols

NEW SYMBOL LIBRARIES UPDATE v4.1

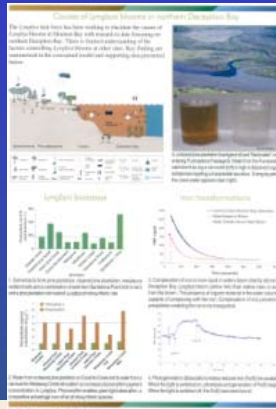
A major update to the IAN Symbol Libraries increasing the total number of symbols from 650 to over 1000.

Includes a new interactive Illustrator Flash tutorial, a searchable PDF of all symbols and a free symbol creation service.

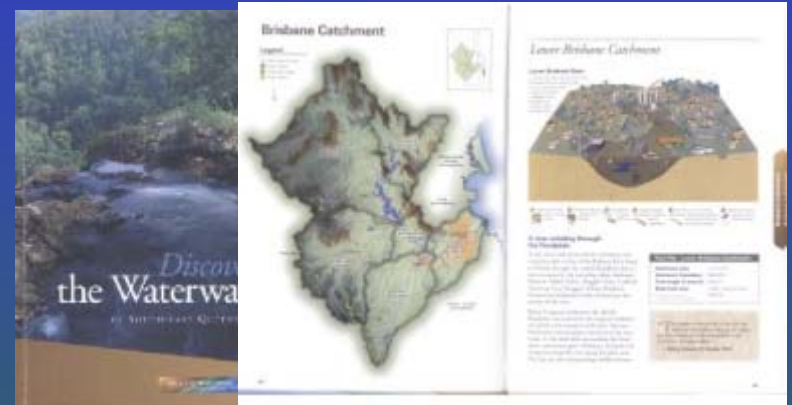


Conceptual diagrams can be incorporated into various products

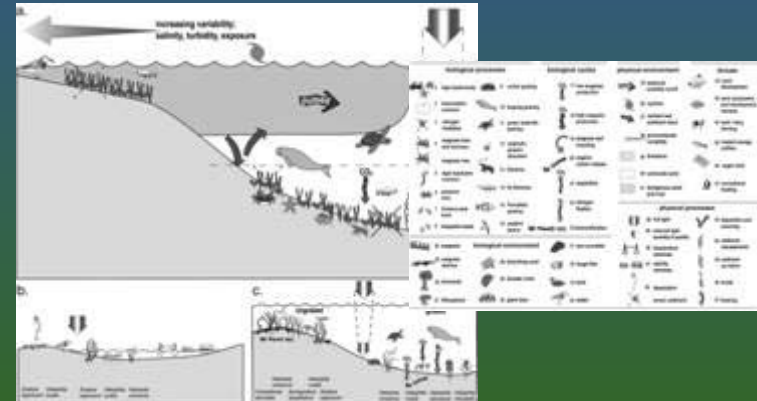
Newsletters



Books



Journal publications



Posters



integration

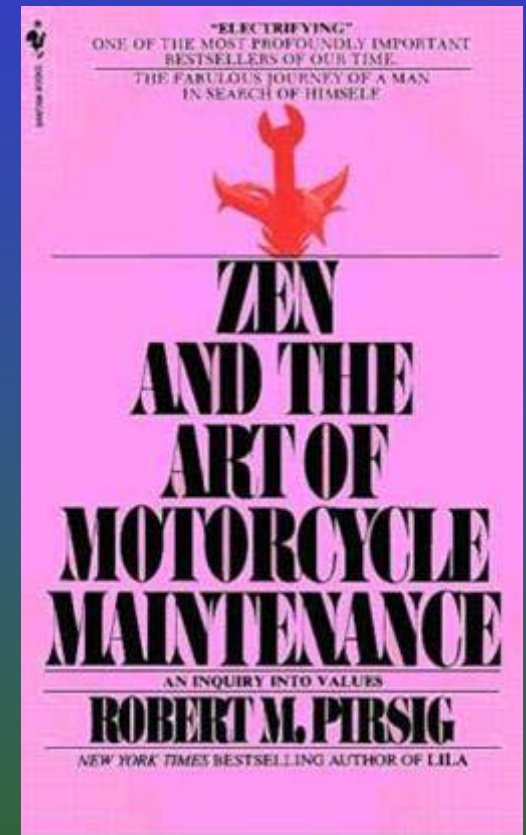
application

network

Conclusion:

replaced "motorcycle maintenance" with "science communication"

“Not everyone understands what a completely rational process this is, this science communication. They think it's some kind of a "knack" or some kind of "affinity for machines" in operation. They are right, but the knack is almost purely a process of reason... Science functions entirely in accordance with the laws of reason, and a study of the art of science communication is really a miniature study of the art of rationality itself.”



Robert Pirsig, 1974



Recommendations

- *Capitalize* on National Park Service unique teaching opportunities
- *Develop and enhance* science communication skills
- *Create or enhance* collection of visual elements (digital libraries)
- *Link* science communication to environmental assessments at parks

Acknowledgements

Tim Carruthers
Jane Thomas
Adrian Jones
Tracey Saxby



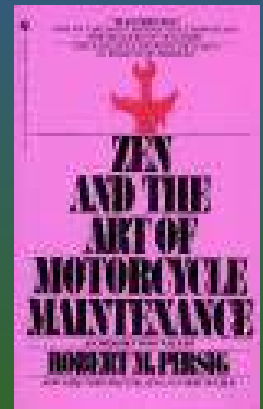
Shawn Carter
John Gross
Steve Fancy



Eva Abal
Paul Greenfield
Francis Pantus



Robert Pirsig



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Science communication resources

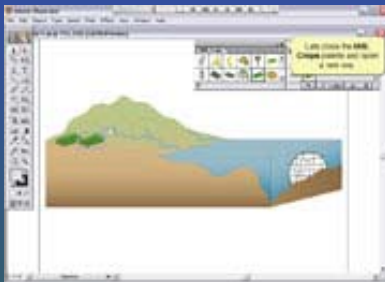
www.ian.umces.edu



Powerpoints



Newsletter



On line tutorial



Handbook



Demonstration
Video



Hands on
courses